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is paying the remainder of the expense, which will be $10,000 or $12,000 more.

The return trip to Château Belair was accomplished without difficulty. It was rendered interesting by a heavy rain squall striking the great crater while I was on the rim. The strong trade wind was blowing a gale as usual, bringing up the clouds in banks from the east-south-east. These curled over the eastern rim of the crater, dived into its depths, concealed the lake for a moment and then swept up and out into the Larikai Valley that descends precipitously to the sea on the west. A black rain cloud came up from the Atlantic and spread its thick mantle over the midday sun, making the crater a dismal abyss and doubling its apparent depth. The rain then fell in torrents, and was driven in sheets against the crater's walls by the fierce wind. The lake was beaten into foam by the thickly falling drops, and cascades drew many snow-white lines down the surrounding precipices. It was a weird and beautiful sight, soon over, but long to be remembered.

At present there is no sign of activity about the Soufrière, not a bit of stream or a fumarole or even a warm spring remaining as a witness of the violent eruptions that occurred so recently. It is not safe to make predictions about volcanoes, but that of St. Vincent seems to be sleeping again and perhaps has entered upon another 90-year period of repose. At any rate, the inhabitants rightly feel warranted in reclaiming such land as was not completely ruined by the eruptions, and they are pushing their cultivation forward season by season in the old regions.

THE DECLINE OF THE LUNAR DISTANCE FOR THE DETERMINATION OF THE TIME AND LONGITUDE AT SEA.

BY

G. W. LITTLEHALES.

In the March number of volume 44 of *Gaea* (1908), there appears an article, under the title "Der gegenwärtige Streit über die beste Methode zur Bestimmung der geographischen Länge auf dem Meere," which is of interest at the present time when the governments of the United States, Great Britain, and France have decided upon the elimination of the lunar-distance tables from the Nautical Almanacs published for the use of navigators. This account impresses upon us the long course of years during which it was deemed necessary to furnish these tables, with the object of facilitating the determination of the time at sea, notwithstanding the uninterrupted growth of the employment by seamen of the marine chronometer for the same purpose.

Some years ago, the late Captain Lecky, one of the most widely known of the English authors upon the subject of navigation, declared, in his characteristic, jocular style, that "Lunars are as dead as Julius Cæsar"; and the last annual report of the Superintendent of the United States Naval Observatory at Washington contains the following passage:

> The tables of lunar distances will be omitted hereafter. Inquiries made in October, 1907, by the Chief of Bureau of Equipment, developed the fact that these tables are practically no longer used by the navigators of either the naval service or of the merchant marine, and authority has been given for their omission, beginning with the volume for 1912.

The lunar-distance tables were omitted from the *Connaissance des Temps* for the year 1905, after having retained their place in the French official ephemeris for 131 years; and from the British Nautical Almanac for 1907, after having been presented annually since the year 1767, when Maskelyne's tables were published.

Not long before the publication of the lunar-distance tables, the first marine chronometer was produced by John Harrison, and, as some years elapsed before this instrument was well known among navigators, the tables probably gained currency among seamen before the chronometer came into general use. Cook observed and calculated over 600 lunar distances to obtain the longitude of Strip Cove, New Zealand; and, in 1777, he observed 1,000 lunar distances to determine the longitude of Tonga-tabu; and all this with inferior instruments for the purpose. Dr. Bolte, observing with the improved instruments of the present day, obtained longitudes with a probable error of 22″ from 34 observations of lunar distances of the sun, and with a probable error of 31″ from observations of the lunar distances of stars.

At sea the observation of a lunar distance requires great accuracy and skill, especially if there be much vibration in the vessel; and it is found that hardly one navigator in two hundred has ever carried out the calculation of a longitude by the lunar-distance method in practice. Although this method can scarcely be said now to survive, it was a good service to have at the disposal of navigators for more than two hundred years the means for carrying it out, and it was a vast improvement upon antecedent methods for the astronomical determination of longitudes, chiefly because scarcely any of these earlier methods could be made available for use at sea.

The early astronomers made use of eclipses of the moon in determining differences of time, as in the instance when the longitude of Toledo from Bagdad was determined by the Arabian astronomer Arzachel; and, in the days of the great discoverers, navigators sometimes attempted to use this method for the purpose of finding the longitudes of distant stations with reference to places in Europe. By means of eclipses of the moon, Columbus found the longitude of a point in the New World to be 108¾° west of Cadiz, but this determination was 40° in error and it was not until long after the generation in which Columbus lived that the facilities for using the method became sufficient to reduce the errors of the longitudes determined in this manner to within 2 minutes of arc. No matter how precise and easy this method might have become, it could never be hoped that it would meet the daily demands for determinations of longitude, because eclipses are not frequent enough for this purpose.

It will be remembered that, during the generations when the minds of investigators were bent on formulating a practical method of determining longitude at sea, Gerhard Mercator proposed the use of the variation of the compass as a means of identifying geographical position, and it may be that this method would have attained a measure of success if it had not been for the successful advent of the chronometer. This is the same Gerhard Mercator who issued the first map or chart by the method of projection which to this day substantially helps in carrying on all the deep-sea commerce of the world.

After Galileo's observations of the moons of Jupiter, Domenico Cassini computed tables of their occultations; and by the aid of these tables Kepler calculated the difference of longitude between Löwen and Vienna within 6′, and Picard and Lahire deduced the longitudes of the most important places in France. As these tables are still somewhat uncertain, but little use is known to have been made of them in our own times beyond their employment by Nansen for finding the longitudes of islands in the Arctic regions.

Another method which was sometimes used by the early voyagers, but which could scarcely be hoped to be adequate to the requirements of navigation, on account of the infrequency of the phenomenon to be observed, was the method of conjunctions. For example, in 1499, on the coast of Venezuela, Amerigo Vespucci observed the moon to be 1° east of Mars at 7:30 o'clock in the evening and 5½° east at midnight. From which it was calculated that these two bodies must have been in conjunction at 6:30 o'clock. But, according to the tables of Regiomontanus (Johann Müller), the same conjunction took place at Nuremberg at midnight, and so the longitude of the point of observation on the coast of Venezuela must have been 5½ hours, or 82½° west of Nuremberg.

It is interesting to look back over the course of progress in determining longitude at sea and review its effect as a contributive agency in advancing geography and benefiting commerce. We may muse upon the stage of the total inability of Columbus to find the time at sea by astronomical observations and see it giving place to the stage of rude approximation which prevailed in the fleets of Lord Nelson; and then meditate upon the advanced conditions of the present day, in which the local time at any meridian can be readily found almost without computation and be compared, for the purpose of finding longitude, with the time as given by chronometers regulated to the prime meridian and kept under perfect control by time-signals, which the observatories send broadcast over the oceans at fixed instants through the agency of wireless telegraphy.

THE DYING PEOPLE OF TAUU.

BY

WILLIAM CHURCHILL.

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